(hereinafter simply core) to create the hollow space in the fibre-reinforced component is manufactured and a mould with a cavity is charged at least with fibre material and the core, and a plastic matrix capable of flowing is injected into the cavity of the closed mould forming a shaped fibre-composite mass soaked in plastic matrix, and the fibre-composite mass is hardened resulting in a fibre-reinforced component. Further, the invention also concerns the production of the core and a device for carrying out the process according to the invention as well as fibre-reinforced components manufactured using the process according to the invention.

A1

the paragraph starting at line 16:

Fibre-reinforced components or fibre composite components are parts made out of fibre-reinforced plastics. They have gained increasing importance because of their relatively light weight and the high strength due to incorporation of fibres in them, this in particular in road and railway vehicles, aircraft construction, aerospace, structures or light weight structures e.g. for reinforcing purposes, or in sports equipment. Fibre-reinforced components also find increasing use as load-bearing structural components in the above fields, whereby such fibre-reinforced components often exhibit extremely complex three-dimensional geometric shapes.

A2



Page 2, the paragraph starting at line 1:

A3.

In the RTM process at least reinforcing fibres, in particular in the form of fibre structures, and as required further components, are placed in the cavity of an open multi-part mould. In a subsequent step a duroplastic or thermoplastic matrix is injected into the cavity of the closed

A3

mould thus forming a fibre-reinforced mass. In a final step the fibre-reinforced mass is hardened or polymerised and the stable-shaped fibre-reinforced component removed from the mould.

Page 3, line 6 insert --SUMMARY OF THE INVENTION--.

Page 4, the paragraph starting at line 36:

A4

Advantageously, the preform is shaped into a core by press-moulding. The pre-form is in particular plastically formed in a press-moulding tool with a shape-forming cavity. The preform is e.g. formed in a multi-part, in particular in a two-part tool containing a shape-forming cavity, whereby the preform is placed in the open-tool cavity and pressed into the contour of the cavity by bringing the parts of the tool together and closing the press-moulding tool. The cavity of the tool usefully reproduces the shape of the hollow space to be created in the fibre-reinforced component. The plastic deformation is usefully completed when the press-moulding tool is completely closed.

the paragraph starting at line 9:

A5

The shape of the press-moulding tool depends on the shape of the core. The parts of the tool may contain partial cavities which on closing the tool together form a closed press-moulding tool cavity. Further, individual press-moulding tool parts may also feature cavity parts which on closing the press-moulding tool form a closed press-moulding cavity. Further, on closing

A5

the press-moulding tool, individual press-moulding tool parts may also be in the form of stems projecting into the cavity.

the paragraph starting at line 25:

A6

The rate at which the deformation process is carried out, i.e. the rate of closing the tool depends on the plastic behaviour or plasticity of the preform, is to be selected such that no brittle behaviour arises and crack formation is avoided. The plastic forming of the preform into the shape of the final core may have a duration e.g. of less than a minute.

Page 6, the paragraph starting at line 31:

A7

In a further version of the invention the core may also be manufactured in an extrusion facility in at least one step involving plastic deformation of a core mass. This solution is particularly suitable if the core is a shaped body of uniform cross-section along its whole length. A core manufactured according to the invention may be of any size e.g. from a few centimeters up to some meters. Likewise the shape of the core has no limits. This may be voluminous, be of a given area, be thin or thick, feature undercuts and other types of complex geometrical shapes.

Page 7, the paragraph starting at line 8:

A8

Apart from waxes the cores may contain fillers such as e.g. mineral type substances. The filler may be employed e.g. to reduce the extent of shrinkage or to influence the temperature of

melting or plasticity. The process described here, however, permits in particular the use of practically pure waxes which exhibit a large degree of shrinkage on solidification, but which have been found by experience to exhibit good run-off melting properties. This means that simply by means of the melting process i.e. without any mechanical aid, the pure waxes can be removed almost completely from the space in the fibre-reinforced component.

A8

Page 9, the paragraph starting at line 12:

Apart from the above mentioned fibre preforms or fibre structures, further reinforcing fibres e.g. textile type, large area fibre structures in the form of layers or laminates may be provided in the fibre-reinforced component. Further, on its outer facing surface in the fibre-reinforced component the fibre preform or fibre structure may be covered over with an outer layer, which enables the fibre-reinforced component to be given a more attractive surface. Also, the fibre-reinforced component with closed or undercut space manufactured according to the invention may – for the purpose of locally increasing the stiffness and resistance to twisting and sagging – be produced in lengths with a sandwich type structure with reinforcing cores, in particular with foam cores of plastic. Apart from supporting cores, the mould may e.g. be fitted in regions with reinforcing cores. Preferred reinforcing cores are foam cores which may be made of polyurethane (PUR), polyvinylchloride (PVC) or a polyolefin. The reinforcing cores may be completely foamed when they are placed in the mould. The reinforcing cores may also be of a kind which, after being placed in the mould, foam out to their final shape during the production of the fibre-reinforced component. The foam core is usefully impervious to fluids. The foam cores may be of the partially or completely open pore type, preferably of the closed

A9

A9

pore type, whereby these are e.g. sealed or closed off at their surface making them impervious to fluids. The reinforcing cores of foam exhibit a density e.g. of 30 – 100 kg/m$^3$, preferably 60 – 80 kg/m$^3$. The manner of introducing a reinforcing core into the mould cavity is the same as for a supporting core.

Page 10, the paragraph starting at line 17:

A10

The through-flow of resin is usefully in a cross-stream manner, whereby the feeding of the plastic matrix into the mould cavity may take place via one or more injection nozzles. The injection pressures are e.g. between 1 and 20 bar, preferably between 3 and 15 bar.

Page 13, the paragraph starting at line 11:

A11

The preform obtained from the melting out process directly from the melted core is again plastically shape-formed into a core. In a preferred version of the invention several preforms are kept in store and preforms are continually taken from store to manufacture the cores. The stocks of cores are continually made up of preforms from melted out cores, so that a balanced number of preforms is always on hand, thus allowing the production of fibre-reinforced components to be increased at short notice. The shape-forming of the preforms into cores is advantageously adjusted with respect to the current number of fibre-reinforced components being produced. After shape-forming, the cores are advantageously fed directly to the production process.

IN THE SPECIFICATION:

Page 1, starting at line 3:

The present invention relates to a process for manufacturing single part fibre-reinforced components having at least one closed or undercut space, in particular a resin-flow moulding [resp.] or a Resin Transfer Moulding (RTM) process, whereby a shape-stable supporting core (hereinafter simply core) to create the hollow space in the fibre-reinforced component is manufactured and a mould with a cavity is charged at least with fibre material and the core, and a plastic matrix capable of flowing is injected into the cavity of the closed mould forming a shaped fibre-composite mass soaked in plastic matrix, and the fibre-composite mass is hardened resulting in a fibre-reinforced component. Further, the invention also concerns the production of the core and a device for carrying out the process according to the invention as well as fibre-reinforced components manufactured using the process according to the invention.

starting at line 16:

Fibre-reinforced components [resp.] or fibre composite components are parts made out of fibre-reinforced plastics. They have gained increasing importance because of their relatively light weight and the high strength due to incorporation of fibres in them, this in particular in road and railway vehicles, aircraft construction, aerospace, structures or light weight [struct-ures] structures e.g. for reinforcing purposes, or in sports equipment. Fibre-reinforced [com-ponents] components also find increasing use as load-bearing structural components in the

above fields, whereby such fibre-reinforced components often exhibit extremely complex three-dimensional geometric shapes.

Page 2, starting at line 1:

In the RTM process at least [fibre-reinforcing] reinforcing fibres, in particular in the form of fibre structures, and as required further components, are placed in the cavity of an open multi-part mould. In a subsequent step a duroplastic or thermoplastic matrix is injected into the cavity of the closed mould thus forming a fibre-reinforced mass. In a final step the fibre-reinforced mass is hardened or polymerised and the stable-shaped fibre-reinforced component removed from the mould.

Page 4, starting at line 36:

Advantageously, the preform is shaped into a core by press-moulding. The pre-form is in particular plastically formed in a press-moulding tool with a shape-forming cavity. The preform is e.g. formed in a multi-part, in particular in a two-part tool containing a shape-forming cavity, whereby the preform is placed in the open-tool cavity and pressed into the contour of the cavity by bringing the parts of the tool together and closing the press-moulding tool. The cavity of the tool usefully reproduces the shape of the hollow space to be created in the fibre-reinforced component. The plastic deformation is usefully completed when the press-[mould-ing] moulding tool is completely closed.

Page 5, starting at line 9:

The shape of the press-moulding tool depends on the shape of the core. The parts of the tool may contain partial cavities which on closing the tool together form a closed press-moulding tool cavity. Further, individual press-moulding tool parts may also feature cavity parts which on closing the press-moulding tool form a closed press-moulding cavity. Further, on closing the press-moulding tool, [individ-ual] <u>individual</u> press-moulding tool parts may also be in the form of stems projecting into the cavity.

starting at line 25:

The rate at which the deformation process is carried out, i.e. the rate of closing the tool depends on the plastic behaviour or plasticity of the preform, is to be selected such that no brittle behaviour arises and crack formation is avoided. The plastic forming of the preform into the shape of the final core may have a duration e.g. of less than a minute.

Page 6, starting at line 31:

In a further version of the invention the core may also be manufactured in an extrusion facility in at least one step involving plastic deformation of a core mass. This solution is particularly suitable if the core is a shaped body of uniform cross-section along its whole length. A core manufactured according to the invention may be of any size e.g. from a few [centimetres] <u>centimeters</u> up to some [metres] <u>meters</u>. Likewise the shape of the core has no limits. This may

be voluminous, be of a given area, be thin or thick, feature undercuts and other types of complex geometrical shapes.

Page 7, starting at line 8:

Apart from waxes the cores may contain fillers such as e.g. mineral type substances. The filler may be employed e.g. to reduce the extent of shrinkage or to influence the temperature of melting or plasticity. The process described here, however, permits in particular the use of practically pure waxes which exhibit a large degree of shrinkage on solidification, but which have been found by [exper-ience] experience to exhibit good run-off melting properties. This means that simply by means of the melting process i.e. without any mechanical aid, the pure waxes can be removed almost completely from the space in the fibre-reinforced component.

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particular with foam cores of plastic. Apart from supporting cores, the mould may e.g. be fitted in regions with reinforcing cores. Preferred reinforcing cores are foam cores which may be made of polyurethane (PUR), polyvinylchloride (PVC) or a polyolefin. The reinforcing cores may be completely foamed when they are placed in the mould. The reinforcing cores may also be of a kind which, after being placed in the mould, foam out to their final shape during the production of the fibre-reinforced component. The foam core is usefully impervious to fluids. The foam cores may be of the partially or completely open pore type, preferably of the closed pore type, whereby these are e.g. sealed or closed off at their surface making them impervious to fluids. The reinforcing cores of foam exhibit a density e.g. of 30 - 100 $kg/m^3$, preferably 60 - 80 $kg/m^3$. The manner of introducing a reinforcing core into the mould cavity is the same as for a supporting core.

Page 10, starting at line 17:

The through-flow of resin is usefully in a cross-stream manner, whereby the feeding of the plastic matrix into the mould cavity may take place via one or more injection nozzles. The injection pressures are e.g. between 1 and 20 bar, [prefer-ably] preferably between 3 and 15 bar.

Page 13, starting at line 11:

The preform obtained from the melting out process directly from the melted core is again plastically shape-formed into a core. In a preferred version of the invention several preforms are kept in store and preforms are continually taken from store to manufacture the cores. The stocks of cores are continually made up of preforms from melted out cores, so that a balanced number of preforms is always on hand, thus allowing the production of fibre-reinforced <u>components</u> to be increased at short notice. The shape-forming of the preforms into cores is advantageously adjusted with respect to the current number of fibre-reinforced components being produced. After shape-forming, the cores are advantageously fed directly to the production process.

Page 14, starting at line 26:

The invention is explained in greater detail by way of example and with reference to the accompanying drawings which show:

Fig. 1a: a schematic cross-sectional view of a preform made of wax;

Fig. 1b: a schematic cross-sectional view of a press-moulding tool with support-ing core;

Fig. 1c: a schematic cross-sectional view of an RTM- mould containing the core and reinforcing fibres;

Fig. 1d: a schematic cross-sectional view of a fibre-reinforced component in the tempering mould;

Fig. 1e: a schematic cross-sectional view of a casting mould; and

Fig. 1f: a schematic cross-sectional view of a fibre-reinforced component.